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Longitudinal assessment of effort-reward imbalance and job strain across pregnancy: A preliminary study

John D Meyer, MD, MPH,

Selikoff Centers for Occupational Medicine and the Pediatric Environmental Health Specialty Unit, Department of Preventive Medicine, Icahn-Mount Sinai School of Medicine, New York, NY

Carles Muntaner, PhD,

Bloomberg Faculty of Nursing, Institute for Global Health Equity and Innovation, Dalla Lana School of Public Health, University of Toronto, Toronto, ON, Canada

Patricia O'Campo, PhD, and

Centre for Research on Inner City Health, St. Michael's Hospital and Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada

Nicolas Warren, ScD

Section of Occupational and Environmental Medicine, Department of Medicine, University of Connecticut Health Center, Farmington CT

Carles Muntaner: carles.muntaner@utoronto.ca; Patricia O'Campo: pat.ocampo@utoronto.ca; Nicolas Warren: warren@nso.uchc.edu

Abstract

Objectives—To assess longitudinal changes in occupational effort-reward imbalance (ERI) and demand-control (DC) scores across pregnancy and examine associations with blood pressure (BP) during pregnancy.

Methods—A pilot repeated-measures survey was administered four times to a sample of working women across pregnancy using the ERI and DC instruments. Demographic data and blood pressure measurements were collected at each interval. Growth mixture modeling was used to examine trajectories of change in occupational characteristics. Associations with BP were examined using repeated-measures linear regression models.

Results—ERI model components (effort, reward, and overcommitment) all declined across pregnancy while job control remained stable. Increasing ERI trajectory was associated with higher systolic BP (b=8.8; p<0.001) as was high overcommitment; declining ERI also showed a smaller association with higher BP. Associations between DC trajectories and BP were much smaller, and non-significant once controlled for overcommitment.

Conclusions—Self-assessed efforts, rewards, and overcommitment at work decline across pregnancy in our participants, while job control remains stable. Replication in a more diverse pregnant working population is warranted to confirm these results. These preliminary data suggest

Correspondence to: John D Meyer MD MPH, Department of Preventive Medicine, Icahn Mount Sinai School of Medicine, 1 Gustave L Levy Place, Box 1057, New York, NY 10029, john.meyer@mssm.edu.

that further investigation into the factors that may be linked with improved work psychosocial climate during pregnancy may be useful in order to improve pregnancy outcomes.

Introduction

Employment has generally been considered advantageous for maternal health and birth outcomes, as a result of the social and economic benefits that accrue to working individuals (1-3). Within the employed however are workers exposed to physical and psychosocial hazards that may be deleterious despite the overall positive effect of employment (4)

Work organization and psychosocial stresses of the workplace have received increasing attention in the past three decades as potential contributors to ill-health. Workplace stressors have been associated with hypertension, cardiovascular disease (5, 6), subclinical atherosclerosis (7), musculoskeletal disorders (8, 9) and mental ill-health (10, 11). Work stressors have been principally measured using the Demand-Control (DC) model, which assesses high work demands (working fast and hard, lack of time, and conflicting requirements) and ability to set the pace and control the conditions of work (12). Job strain, the adverse combination of high demands with low control in the DC model, has shown a variable relationship to poor pregnancy outcomes, with conflicting study results (13-19). However, even in studies showing no overall association between work and pregnancy outcomes, there are indications that high job strain may increase risk in subsets of pregnant women. A socioeconomic gradient in risk, and an increased likelihood of preterm delivery from continuing full-time work in a high-strain job after 30 weeks gestation were noted in one study (16).

Equivocal results from the demand-control model, suggest that testing an alternative model of occupational psychosocial stress, and its effect on pregnant working women, may be worthwhile. The effort-reward imbalance (ERI) model was developed in the 1990s to incorporate both individual differences in adaptive style and broader socioeconomic factors to the appraisal of working conditions (20, 21). The ERI model postulates that lack of reciprocity between effort spent and rewards received in work elicits sustained reactions in the autonomic nervous and endocrine systems (20). The ERI questionnaire assesses effort at work (time pressures and demands), and perceived reward, which includes three subdomain components of esteem, job promotion and job security. An additional measure of overcommitment (21, 22) incorporates intrinsic or personal characteristics that may mediate personal or subjective experiences of stressors. A focus of the ERI model on salaries, promotion prospects, and job stability more explicitly links stressful experience at work with broader labor market conditions (21). It also may also reflect stressors of a service economy, whereas the DC model originated from surveys in the early 1970s when manufacturing work predominated. (23, 24) Comparative studies demonstrated independent predictive effects of the ERI and the low-control component of the DC model for new coronary artery disease (25) and greater predictive power for the ERI over the DC model for measures of general stress (26). Differential, gender-specific effects of the psychosocial work environment on health are also suggested by the ERI. Stronger effects on cardiovascular risk factors in women were associated with high overcommitment in the ERI (21) possibly through “dual exposure” to psychosocial stressors in the workplace and at home, conflicting role obligations (family-work conflicts), and less continuity in career pathways. These findings have salience for measurement of occupational stress during pregnancy.

Although the burden of workplace stressors on pregnancy outcomes is difficult to quantify, elevated risks of 1.3 to 1.4 for low birth weight (LBW) and preterm delivery (PTD) in some studies indicate that reduction in the psychosocial hazards of employment may be beneficial (16, 17). Over 60% of women giving birth are employed, and most remain in employment into the third trimester, which suggests the breadth of exposure may be substantial, particularly with high women's employment in service and retail sectors (27, 28). Further, occupational factors, once identified, may be modifiable sources of risk (29, 30). In light of changes in work across recent decades and the somewhat low predictive value of the DC model in pregnancy, we proposed to explore the use of the effort-reward imbalance model of psychosocial working conditions, which has been tested in pregnant workers only once to date (19). Prior to its use in larger-scale studies, we considered relevant preliminary questions. The first is whether occupational psychosocial stressor scores exhibit significant temporal variation as pregnancy progresses. Variation within an individual's scores during pregnancy may imply that trajectories in stressors are the exposure metric of interest, as well as indicating where temporal modifying factors may be found. A second question is whether sufficient heterogeneity of stressor scores is seen. Adequate exposure contrast between groups is critical if effects on gestational events are to be measured, and in planning studies with sufficient power to detect associations with adverse outcomes. We report the results of a pilot study assessing longitudinal changes in DC and ERI scores across four points across pregnancy in employed women, and we examine associations of ERI during pregnancy with blood pressure, both an important index of maternal health and a previously-described effect in non-pregnant populations.

Methods

We report on a repeated-measures questionnaire survey of pregnant women who were working full-time at conception. A sample was recruited through offices and clinics providing obstetrical care in the Hartford and New Haven areas of Connecticut. Approval for this study was obtained from the Institutional Review Board of the University of Connecticut Health Center. Volunteers were eligible if they were currently pregnant, presented for prenatal care in the first trimester (8-12 weeks gestation), and were in current paid work, defined as 30 hours or more per week outside the home, at the time of enrollment. Evidence of multiple gestation was grounds for exclusion, as this may alter decisions on reduction of work. Volunteers were also ineligible if the current pregnancy arose from infertility treatment, as they may have modified work to accommodate treatment. History of a prior poor pregnancy outcome was not an exclusion criterion, unless there was medically-ordered work reduction early in the current pregnancy based on the outcome of a prior pregnancy.

After screening for eligibility, an initial interview lasting 45-60 minutes was scheduled. Informed consent was obtained at the initial interview. The study questionnaire was administered in-person at or before 12 weeks gestation. The survey comprised items from the Effort-Reward Imbalance and Job Content questionnaires. The ERI instrument, published by Siegrist et al (20), includes three major factors: effort (6 questions, including one on physical load), reward (11 questions on three subscales: esteem, job promotion, and job security), and overcommitment (6 questions) (20, 25). Initially, subjects are asked to agree or disagree whether the item represents a typical experience of their work situation; subjects who agree then evaluate the extent they feel distressed by the experience. Answers are scaled from 1 to 5 (20) Aggregate scores can range from 6 to 24 for effort and for overcommitment, and 11 to 55 for reward. Reversed coding was used to indicate higher levels of reward.

Domains of the Demand-Control model were measured using a shortened version of the Karasek Job Content Questionnaire (JCQ) (12). Workplace demands were considered equivalent to the effort scale of the ERI questionnaire, a common procedure in studies using both ERI and DC instruments (19, 22). Nine questions were used to assess job control, including control over the pace and content of work, decision authority/latitude, and skill discretion. Measurement was on a four-point scale from strong agreement to strong disagreement.

Demographic and obstetric information (age, ethnicity/race, gravidity and parity, educational level, smoking, alcohol use), health status (presence of chronic or ongoing disease) and socioeconomic variables associated with maternal health and preterm delivery, including partner employment, income (both individual and total household) and health insurance were collected. Brief self-reported indices of fatigue and general health were obtained as single-item measures. A single-item index of stress symptoms was also requested; a brief definition of stress was provided and the degree to which participants agreed that it represented their current experience was recorded on a four-point scale (31). Seated resting blood pressure (BP) was taken after interview using a standardized protocol (32)

Pregnant subjects were surveyed three additional times during the pregnancy: at mid-to-late second trimester (20-24 weeks), early third trimester (28-31 weeks), and later third trimester (35-38 weeks). Interviews reprised questions from the ERI and JCQ, re-assessed physical and home demands, and any intervening job modifications or complications of pregnancy since the previous survey. The single-item measures of self-reported stress, fatigue and health were repeated, and BP measurements again recorded. If a subject left work in the interval since the last interview, the date of last work was noted, and the reason for leaving recorded. Interviews with subjects who left work continued data collection on home demands, self-reported stress, health, and BP readings. Participants were recontacted post-partum, and date of delivery and birth weight were obtained.

Data from the questionnaires were recorded on optically scanned forms, and downloaded into an SPSS database (v.21, SPSS/IBM Analytics), inspected and cleaned. A 10% sample of responses was selected randomly and paper records compared to digital data for quality control. Demographic and occupational variables were tabulated and examined. Mean values and standard deviation were calculated for aggregate effort, reward, overcommitment and control scores, stress, fatigue, and health scores, and blood pressure. Effort-reward imbalance was calculated as a ratio of the two scores weighted for the number of questions (effort/[reward*0.4545]) using published guidance (20). Demand-control ratios were calculated similarly as a weighted ratio, using effort score as an equivalent to job demands. Job strain, a dichotomous classification, was defined as a combination of effort score above the median value and control score below the median for each interview wave (12). Generalized linear regression models were used to examine the association of ERI and DC scores at each interview wave with systolic blood pressure. Since nearly all ERI scores were above 1, the usual cut-off for determining elevated effort-reward imbalance, we used a cutoff of 1.5 to dichotomize ERI scores into high versus low.

Growth mixture modeling (GMM) was used to group subjects into a set of trajectory classes that were representative of changes in work ERI and DC scores over the four interview waves. GMM is a form of latent class analysis which estimates and assigns membership of each participant to a limited number of latent classes, based on the closeness of fit of their intra-individual changes across the survey (33, 34). GMM was performed using the mixture modeling function in Mplus v.6.11 (Muthén and Muthén, Los Angeles, CA), using data from subjects who had completed at least three of the four interviews. Determination of the best-fitting trajectory class solution was based on 3 statistical factors including Bayesian Information Criterion scores for each model, likelihood ratio tests, and entropy score, a measure of classification certainty (33, 35).

The association of ERI and DC trajectory classes with blood pressure was modeled using generalized estimating equations (GEE) to account for autocorrelation in repeated BP measurements. Models incorporated adjustment for maternal age, maternal education, race/ethnicity, smoking, prior history of gestational hypertension, and maternal body-mass index (BMI) as potential confounders for blood pressure. GEE and GLM analyses were performed in SPSS v21. 95% confidence intervals were calculated for estimates of effect.

Results

A total of 61 women were enrolled and completed the initial interview at or before 12 weeks gestation. Of this group, 57 (93%) completed two interviews, 55 (90%) three, and 49 completed all four interview waves, an overall completion rate of 80.3%. Of those who did not complete all interviews, six (9.8%) experienced a miscarriage or non-viable early delivery and four (6.6%) had a preterm live delivery. Only two still-pregnant women (3.3%) were unable to attend the final fourth interview. Demographics of the sample are shown in Table I. Mean age of the participants was close to the mean maternal age at delivery in Connecticut of 29.2 years, as was distribution by race/ethnicity (3). Educational attainment and maternal income were both higher than the overall mean for Connecticut maternal data, while the proportion of current smokers was lower. Disproportionately more participants worked in the health care and social service industry, although a broad range of industries was represented. Infants' birth weights were obtained from the mother for all live births regardless of whether all surveys were completed; excluding six miscarriage/non-viable deliveries, mean birthweight (3416 grams) was slightly higher than that of working women in Connecticut (3384g). Two babies (3.6%) weighed below 2500g while one weighed over 4500g.

Mean values for work factor scores for subjects completing all four interview waves are shown in Table II, along with self-rated health and stress scores and systolic blood pressure. All component scores on the ERI questionnaire showed a decline across pregnancy, these differences were statistically significant between the first and final waves. As a consequence of this parallel decline, effort-reward imbalance scores remained stable across the four interviews (mean difference 0.09 in ERI scores between wave 1 and 4; p=0.44). Job control scores remained stable throughout pregnancy. The proportion of subjects classified into the job strain category declined across waves due to falling job demand (effort), although not significantly different across waves (p=0.21 by Fisher's exact test). Self-rated stress and fatigue scores declined and then rose slightly across surveys. Blood pressure values showed small declines in mid-pregnancy with mild increase at the final wave, consistent with known changes across pregnancy. Inclusion of all subjects, regardless of the number of survey waves completed, did not appreciably change the mean scores nor the observed declines in ERI score components (results not shown).

Associations of elevated ERI and job strain with systolic BP and birth weight at each separate wave were not statistically significant, nor was there evidence of a trend in outcomes across waves for either construct (results not shown).

Results of latent growth trajectory models for ERI and DC scores across pregnancy are shown in Figure 1. In both cases, a three-class solution demonstrated the best fit. For the ERI, the majority of participants' trajectories (44; 79%) remained stable with a mean ERI value slightly above 1.5. A second class (Class 2; 14%) demonstrated a steady decline in ERI over pregnancy, while a third, smaller group (Class 3; 7%) showed a rise in scores. DC trajectories showed roughly half (46%) of participants in a low-stable trajectory, with two other groups having elevated-stable (21%) and high-declining (32%) trajectories. Modeling of overcommitment trajectories showed two stable flat classes: a low- overcommitment class (the majority, 87.5%), and a second class with consistently high overcommitment. There was no evidence of clustering by industry sector in any of the three trajectory models (p>0.50 by Fisher's exact test).

Table III presents regression results testing associations between work trajectories and SBP. H Compared with the stable-flat trajectory class, higher SBP was seen in both the increasing- and declining-ERI-trajectory classes, the former more strongly. Associations were attenuated, but not abolished, by the inclusion of overcommitment. The high overcommitment class was independently associated with higher SBP. Higher demand-control ratio in early pregnancy was also associated with increased SBP, although the magnitude of the association in all DC classes was lower than seen with increasing ERI. These associations were abolished by the inclusion of overcommitment. The declining ERI trajectory class was associated with higher birthweight (B-coefficient 408 grams; p=0.015 versus the stable referent category; results not shown) although numbers of births were too small to drawn clear conclusions.

Discussion

We present a preliminary longitudinal exploration of the effort-reward imbalance and demand-control models during pregnancy. In contrast to the DC model of psychosocial work stress, components of the ERI model have only recently been applied to the evaluation of work during pregnancy. Lee and colleagues (19) noted an association of effort-reward ratio with gestational age, but not with birthweight, in Korean mothers and similarly found no association of high job strain at mid-pregnancy with subsequent birthweight.

Although preliminary, several aspects of the results we present here are noteworthy. The steady decline in factor scores for the ERI model across employment during pregnancy has not heretofore been described. Effort and overcommitment scores declined significantly over the course of pregnancy, with reward following a similar, although less marked, pattern. As a consequence, the mean effort-reward imbalance score remained nearly constant, although the decline in both components suggests a more dynamic process over the course of pregnancy. Job control, by contrast remains nearly constant throughout surveys, suggesting a more static construct. These findings indicate that the pregnant worker's assessment of work is changing across the course of pregnancy. The stability of DC scores may underscore the differences in the two constructs in measuring aspects of the work environment. DC taps into structural organizational characteristics and could be expected to remain stable within a given job. ERI by contrast will encompass workers' subjective appraisal and could be expected to change (36), perhaps markedly. The subjective assessment of effort and rewards may itself be modified by the pregnancy. When assessed together, the two models independently predicted cardiovascular disease in several European studies, which again suggests that job control assesses invariant daily tasks while the ERI models appraisal of a more global view of one's career (21, 25). The choice of blood pressure measurement as an index of health during pregnancy may not be the most representative indicator. However, SBP is associated with both the work exposures we measure, as described above, and with adverse outcomes such as low birth weight, leading us to use it as a potential indicator of maternal health. Though we note changes in BP consistent with well-described patterns across pregnancy, we also find associations consistent with known effects of work stress.

Pregnancy may lead subjects to reassess occupational rewards in the light of high work effort, while at the same time, skill discretion, job tasks, and the means by which to perform them (the DC model) remain relatively constant (37). Physiologic factors and changes in body habitus that accompany pregnancy may likewise lead one to modify job efforts in response to physical capabilities or perceptions of hazards at work (30). Capacity to modify the work, to take time away or to change working hours, as well as perceptions of work-family conflict (38), are likely important factors in assessment of effort and reward. These additional data were collected as part of this survey, and, having demonstrated change across pregnancy the next step is to analyze their role as mediators or moderators of our results.

The results presented here are subject to several limitations which should be acknowledged. As a preliminary exploration of the feasibility of multiple measurements across pregnancy, the sample size was necessarily a small one. This raises the possibility of a study underpowered for the effects it seeks to discern. We had originally estimated that 110 subjects would be required to detect a 2-point difference in effort and reward scores across pregnancy, although we also had estimated greater drop-out (40%) from losses to follow-up. Power calculations were also not based on an association with birthweight, for which the variability is high. Confounding, and possibly recruitment bias, may also operate. The volunteer recruitment strategy yielded a sample that was comparable to Connecticut's maternal ethnic and age distribution, but was more educated and better-paid, with over-representation in health-care employment. This reflects the demographics of employment in the area, but may not be representative of diverse working populations. Our participants were likely at some reduced risk for poor health and pregnancy outcomes. Moreover, factors such as the ability to adapt one's working conditions to the pregnancy may be very different in this group than in a population with less training or discretion at work. These correlates likely affect workers' overall estimation of effort and reward, although we cannot be certain of the magnitude of this possible bias. In less-advantaged respondents, the effects of work on health may be one of numerous concomitant deleterious exposures, including neighborhood, housing, or food insecurity (39).

With these limitations in mind, however, we believe that our preliminary results indicate the value of the ERI model to begin to examine dynamic effects of occupation on pregnancy and reproductive outcomes, and the usefulness of describing trajectories of occupational stressors across pregnancy. The ability to change or modify work, or, conversely, the accumulation of stressors, may have an important role in determining health outcomes (35, 40), consistent with the ‘weathering’ hypothesis whereby accumulated disadvantage (including that at work) produces an erosive effect on health (41-44). Further work would be directed toward examining these associations in a larger, more broadly employed population. Additionally the ERI model may represent a set of flexible work characteristics which may be more amenable to short-term alteration. The declines we observe in effort, reward and overcommitment scores, not paralleled by declining job control scores, may imply differences in short-term work assessment. Equally important may be to identify those modifiable elements of work within the broader constructs of the ERI. The ability to modify work when pregnant or to take time away, or workplace policies on work flexibility in pregnancy, may change the degree to which occupational stressors are implicated in pregnancy outcomes.

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References

1. Murphy JF, Dauncey M, Newcombe R, Garcia J, Elbourne D. Employment in pregnancy: prevalence, maternal characteristics, perinatal outcome. Lancet. 1984; 1(8387):1163–6. [PubMed: 6144885]
2. Saurel-Cubizolles MJ, Zeitlin J, Lelong N, Papiernik E, Di Renzo GC, Breart G. Employment, working conditions, and preterm birth: results from the Europop case-control survey. J Epidemiol Community Health. 2004; 58(5):395–401. [PubMed: 15082738]
3. Meyer JD, Nichols GH, Warren N, Reisine S. Maternal occupation and risk for low birth weight delivery: Assessment using state birth registry data. J Occup Environ Med. 2008; 50(3):306–315. [PubMed: 18332780]

4. Savitz DA, Olshan AF, Gallagher K. Maternal occupation and pregnancy outcome. Epidemiology. 1996; 7(3):269–74. [PubMed: 8728440]
5. Landsbergis P, Schnall PL, Belkic KL, Baker D, Schwartz J, Pickering TG. Work stressors and cardiovascular disease. Work. 2001; 17(3):191–208. [PubMed: 12441599]
6. Karasek R. Job strain and the prevalence and outcome of coronary artery disease. Circulation. 1996; 94(5):1140–1. [PubMed: 8790062]
7. Muntaner C, Nieto FJ, Cooper L, Meyer J, Szklo M, Tyroler HA. Work organization and atherosclerosis: findings from the ARIC study. Atherosclerosis Risk in Communities. Am J Prev Med. 1998; 14(1):9–18. [PubMed: 9476831]
8. Warren N, Dillon C, Morse T, Hall C, Warren A. Biomechanical, psychosocial, and organizational risk factors for WRMSD: population-based estimates from the Connecticut upper-extremity surveillance project (CUSP). J Occup Health Psychol. 2000; 5(1):164–81. [PubMed: 10658894]
9. MacDonald LA, Karasek RA, Punnett L, Scharf T. Covariation between workplace physical and psychosocial stressors: evidence and implications for occupational health research and prevention. Ergonomics. 2001; 44(7):696–718. [PubMed: 11437204]
10. Muntaner C, Van Dussen DJ, Li Y, Zimmerman S, Chung H, Benach J. Work organization, economic inequality, and depression among nursing assistants: a multilevel modeling approach. Psychol Rep. 2006; 98(2):585–601. [PubMed: 16796118]
11. Soderfeldt B, Soderfeldt M, Jones K, O'Campo P, Muntaner C, Ohlson CG, et al. Does organization matter? A multilevel analysis of the demand-control model applied to human services. Soc Sci Med. 1997; 44(4):527–34. [PubMed: 9015887]
12. Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B. The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. J Occup Health Psychol. 1998; 3(4):322–55. [PubMed: 9805280]
13. Ceron-Mireles P, Harlow SD, Sanchez-Carrillo CI. The risk of prematurity and small-for-gestational-age birth in Mexico City: the effects of working conditions and antenatal leave. Am J Public Health. 1996; 86:825–31. [PubMed: 8659657]
14. Escriba-Aguir V, Perez-Hoyos S, Saurel-Cubizolles MJ. Physical load and psychological demand at work during pregnancy and preterm birth. Int Arch Occup Environ Health. 2001; 74:583–8. [PubMed: 11768048]
15. Brandt LP, Nielsen CV. Job stress and adverse outcome of pregnancy: a causal link or recall bias? Am J Epidemiol. 1992; 135(3):302–11. [PubMed: 1546706]
16. Brett KM, Strogatz DS, Savitz DA. Employment, job strain, and preterm delivery among women in North Carolina. Am J Public Health. 1997; 87(2):199–204. [PubMed: 9103097]
17. Oths KS, Dunn LL, Palmer NS. A prospective study of psychosocial job strain and birth outcomes. Epidemiology. 2001; 12(6):744–6. [PubMed: 11679805]
18. Meyer JD, Warren N, Reisine S. Job control, substantive complexity, and risk for low birth weight and preterm delivery: An analysis from a state birth registry. Am J Ind Med. 2007; 50(9):664–675. [PubMed: 17676587]
19. Lee BE, Ha M, Park H, Hong YC, Kim Y, Kim YJ, et al. Psychosocial work stress during pregnancy and birthweight. Paediatr Perinat Epidemiol. 2011; 25(3):246–54. [PubMed: 21470264]
20. Siegrist J, Starke D, Chandola T, Godin I, Marmot M, Niedhammer I, et al. The measurement of effort-reward imbalance at work: European comparisons. Soc Sci Med. 2004; 58(8):1483–99. [PubMed: 14759692]
21. Peter R, Siegrist J, Hallqvist J, Reuterwall C, Theorell T. Psychosocial work environment and myocardial infarction: improving risk estimation by combining two complementary job stress models in the SHEEP Study. J Epidemiol Community Health. 2002; 56(4):294–300. [PubMed: 11896138]
22. Ostry AS, Kelly S, Demers PA, Mustard C, Hertzman C. A comparison between the effort-reward imbalance and demand control models. BMC Public Health. 2003; 3:10. [PubMed: 12636876]
23. Muntaner C, Schoenbach C. Psychosocial work environment and health in U.S. metropolitan areas: a test of the demand-control and demand-control-support models. Int J Health Serv. 1994; 24(2): 337–53. [PubMed: 8034396]

24. Muntaner C, O'Campo PJ. A critical appraisal of the demand/control model of the psychosocial work environment: epistemological, social, behavioral and class considerations. Soc Sci Med. 1993; 36(11):1509–17. [PubMed: 8511639]
25. Bosma H, Peter R, Siegrist J, Marmot M. Two alternative job stress models and the risk of coronary heart disease. Am J Public Health. 1998; 88(1):68–74. [PubMed: 9584036]
26. Calnan M, Wadsworth E, May M, Smith A, Wainwright D. Job strain, effort--reward imbalance, and stress at work: competing or complementary models? Scand J Public Health. 2004; 32:84–93. [PubMed: 15255497]
27. Laughlin, LL. U.S. Census Bureau. Maternity leave and employment patterns of first-time mothers : 1961-2008. Washington, D.C.: U.S Dept of Commerce, Economics and Statistics Administration, U.S. Census Bureau; 2011.
28. United States. Bureau of Labor Statistics. Women in the labor force : a databook. Washington, D.C.: U.S. Dept. of Labor, Bureau of Labor Statistics; 2006.
29. American College of Obstetricians and Gynecologists. Exposure to toxic environmental agents. Committee Opinion No. 575. Obstet Gynecol. 2013; 122(4):931–5. [PubMed: 24084567]
30. Croteau A, Marcoux S, Brisson C. Work activity in pregnancy, preventive measures, and the risk of delivering a small-for-gestational-age infant. Am J Public Health. 2006; 96(5):846–55. [PubMed: 16571706]
31. Elo AL, Leppanen A, Jahkola A. Validity of a single-item measure of stress symptoms. Scand J Work Environ Health. 2003; 29(6):444–51. [PubMed: 14712852]
32. Schnall PL, Pieper C, Schwartz JE, Karasek RA, Schlussel Y, Devereux RB, et al. The relationship between ‘job strain,’ workplace diastolic blood pressure, and left ventricular mass index. Results of a case-control study. Jama. 1990; 263(14):1929–35. [PubMed: 2138234]
33. Sturgis P, Sullivan L. Exploring social mobility with latent trajectory groups. Journal of the Royal Statistical Society: Series A (Statistics in Society). 2008; 171(1):65–88.
34. Muthen B, Muthen LK. Integrating person-centered and variable-centered analyses: growth mixture modeling with latent trajectory classes. Alcohol Clin Exp Res. 2000; 24(6):882–91. [PubMed: 10888079]
35. Mutambudzi M, Meyer JD. Construction of early and midlife work trajectories in women and their association with birth weight. Am J Public Health. 2014; 104(Suppl 1):S58–64. [PubMed: 24354827]
36. Krause N, Burgel B, Rempel D. Effort-reward imbalance and one-year change in neck-shoulder and upper extremity pain among call center computer operators. Scand J Work Environ Health. 2010; 36(1):42–53. [PubMed: 19967325]
37. de Jonge J, Bosma H, Peter R, Siegrist J. Job strain, effort-reward imbalance and employee well-being: a large-scale cross-sectional study. Soc Sci Med. 2000; 50(9):1317–27. [PubMed: 10728851]
38. Frone M, Russell M, Barnes GM. Work-family conflict, gender, and health-related outcomes: a study of employed parents in two community samples. J Occup Health Psychol. 1996; 1:57–69. [PubMed: 9547034]
39. Blumenshine P, Egerter S, Barclay CJ, Cubbin C, Braveman PA. Socioeconomic disparities in adverse birth outcomes: a systematic review. American Journal of Preventive Medicine. 2010; 39(3):263–72. [PubMed: 20709259]
40. Meyer JD, Mutambudzi M. Construction of life-course occupational trajectories: evidence for work as a mediator of racial disparities in hypertension. J Occup Environ Med. 2012; 54(10):1201–7. [PubMed: 22995805]
41. Geronimus AT. Understanding and eliminating racial inequalities in women's health in the United States: the role of the weathering conceptual framework. J Am Med Womens Assoc. 2001; 56(4): 133–6. 149–50. [PubMed: 11759779]
42. Quinn MM, Sembajwe G, Stoddard AM, Kriebel D, Krieger N, Sorensen G, et al. Social disparities in the burden of occupational exposures: Results of a cross-sectional study. Am J Ind Med. 2007; 50(12):861–75. [PubMed: 17979135]
43. Krieger N. Embodying inequality: a review of concepts, measures, and methods for studying health consequences of discrimination. Int J Health Serv. 1999; 29(2):295–352. [PubMed: 10379455]

44. Singh-Manoux A, Ferrie JE, Chandola T, Marmot M. Socioeconomic trajectories across the life course and health outcomes in midlife: evidence for the accumulation hypothesis? Int J Epidemiol. 2004; 33(5):1072–9. [PubMed: 15256527]

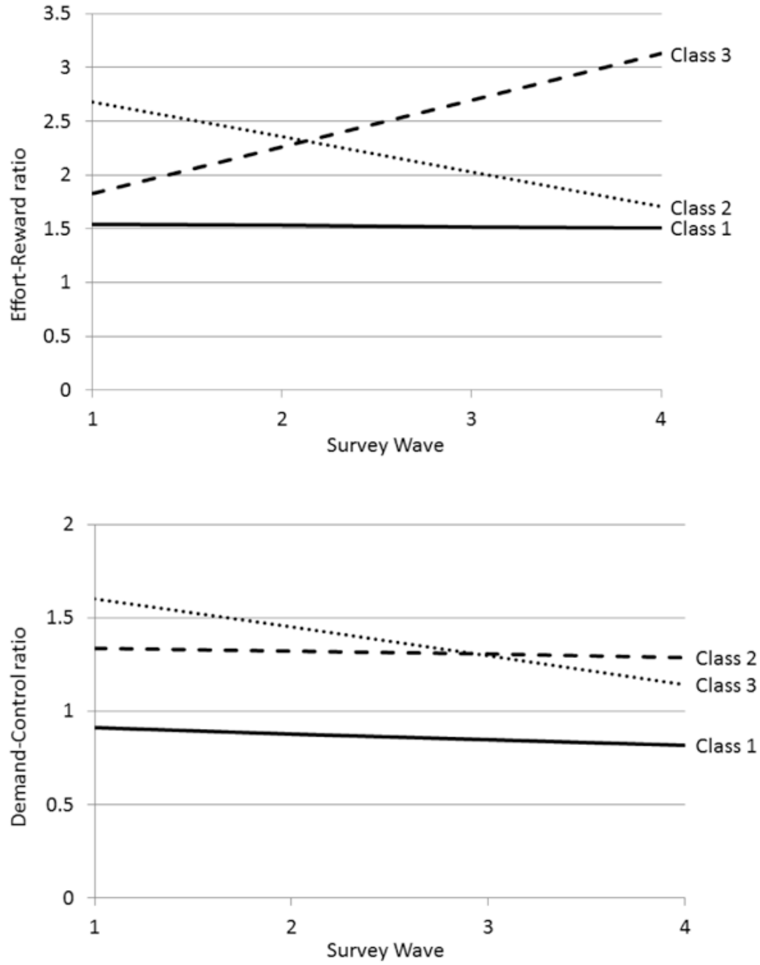

Figure 1. Graphs showing mean trajectories for three-class growth mixture modeling for ERI (upper panel) and DC ratio (lower panel) across four survey waves

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Table I

Characteristics of participants in study at time of entry (gestational age ≤ 12 weeks)

Age at first interview (mean, SD)	30.9	SD 3.6
First pregnancy (N, %)	20	33%
Education (N, %)		
High School Diploma or GED	3	5%
Less than 2 years college	5	8%
Associate degree ≥ 2 years college	6	10%
Bachelor's or 4 year degree	18	30%
Master, Doctoral or Professional degree	29	48%
Ethnicity (N, %)		
White	46	75%
African-American or Black	8	13%
Hispanic or Latin American	7	12%
Own Personal Yearly Income (N, %)		
$29,000 or below	6	9.8%
$30,000 to $49,000	17	27.9%
$50,000 to $99,000	34	55.7%
$100,000 or more	3	4.9%
Insurance Status (N, %)		
HMO	40	65.6%
Private Insurance	19	31.1%
Medicaid or state welfare	1	1.6%
Other	1	1.6%
Marital Status (N, %)		
Married, living with spouse	49	80.3 %
Not married, living with partner/baby's father	7	11.5%
Not married, living on own	3	4.9%
Unknown/Refused	2	3.3%
Smoking Status (N, %)		
No, and did not before pregnancy	52	85.2%
No, but smoked before pregnant	7	11.5%
Yes, one half pack per day or less	2	3.3%
Body-Mass Index (BMI) (mean, SD)	26.8	6.2
Industry Sector of current job (N, %)		
Health and Social Service	36	59%
Professional, Scientific, Management & Administration	8	13%
Finance and Insurance	4	7%
Information	4	7%
Manufacturing	3	5%
Education	3	5%
Other Services	2	3%

Retail Trade	1	2%
Pregnancy Outcomes:		
Baby's birth weight in grams (mean, SD)	3416	522
Gestational age at delivery in weeks (mean, SD)	39.2	2.6

Table II

Job characteristic scores, self-rated fatigue and stress, and blood pressure measurements across interview waves during pregnancy for participants responding to all four surveys. N= 49

		Interview wave							
		1		2		3		4	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Effort		14.9	4.5	13.6†	4.3	13.3**	4.0	12.9**	5.0
Reward		19.9	7.6	18.0†	6.3	18.1†	6.4	18.0†	6.3
Effort-Reward Imbalance		1.79	0.64	1.76	0.59	1.77	0.74	1.70	0.73
Overcommitment		13.7	5.9	12.6*	5.4	11.8**	5.7	11.3**	5.9
Job Control		12.4	2.1	12.4	2.0	12.8	2.2	12.5	2.4
Job Strain: N (%)		18	37%	14	29%	8	16%	7	14%
Fatigue Score		67	23	48	25	56	22	67	21
Stress (self-rated)		2.9	0.9	2.5	1.1	2.7	0.8	2.8	1.0
Blood Pressure (mmHg)	**Systolic**	114	10	113	11	115	13	118*	11
	Diastolic	70	9.6	68	8.4	69	8.6	74*	7.5

† p<0.10 by paired t-test versus score at interview wave 1

* p<0. 05 by paired t-test versus score at interview wave 1

** p<0.01 by paired t-test versus value at interview wave 1

Table III

Association of systolic blood pressure and birthweight with effort-reward imbalance and job demand-control trajectories across interview waves.

	Systolic Blood Pressure					
	Model 1			Model 2		
	B	**SE**	**p**	**B**	**SE**	**p**
ERI Trajectory						
Stable/Flat	REF	-	REF	REF	-	REF
Declining	5.3	2.1	0.01	3.7	1.9	0.05
Increasing	12.1	3.7	0.001	8.8	2.7	0.001
Overcommitment						
High				6.7	1.7	0.001
Low				REF	-	REF
D-C Trajectory						
Low – Stable	REF	-	REF	REF	-	REF
High – Stable	4.8	2.5	0.06	3.3	2.3	0.10
High - Declining	5.8	2.3	0.01	3.6	2.2	0.16
Overcommitment						
High				7.9	2.2	0.001
Low				REF	-	REF

All models were adjusted for maternal age, maternal education, race/ethnicity, smoking, and maternal body-mass index (BMI). SBP models were also adjusted for prior history of gestational hypertension; Birthweight models were adjusted for gestational age at delivery. Model 2 represents inclusion of overcommitment trajectories as an additional factor.